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PATENT APPLICATION

Assistant Commissioner for Patents
Box **Patent Application**
Washington, D. C. 20231

Sir:

Enclosed herewith for filing under the provisions of 37 CFR § 1.53 (b) is the following continuation in part application of the prior, co-pending patent application Serial No. 09/293,526, filed on April 15, 1999 and copending U.S. Patent Application serial number 09/201,528, filed November 30, 1998, both herein incorporated into the present continuation in part application by reference. This application also claims priority to U.S. Provisional Application, serial no.60/093,891, filed July 23, 1998. which is hereby incorporated herein by reference.

Applicant(s): **Edward A. Ludvig, Donald F. Gordon, Nathan W. Osborn, Sadik Bayrakeri**

Title of application: **METHOD AND APPARATUS FOR ENCODING A USER INTERFACE**

Pages of specification: 26 (including 5 pages of claims and 1 page abstract)

Sheets of drawing: 6

Executed on:_____ Docket No.: **533/168 CIP1**

PATENT APPLICATION FILING FEE CALCULATION

	No. Filed	Less	Rate/Claim	Fee
Total Claims	29	-20	9 x $9.00	$ 81.00
Independent Claims	6	-3	3 x $39.00	$117.00
			Minimum Filing Fee	$ 760.00
			Multiple Dependency Fee (if applicable - $230.00)	$_____

50% Reduction for Small Entity (Independent Inventor, Non-profit Corporation, or Small Business Concern) - appropriate verified statement attached	- $380.00
TOTAL FILING FEE	$578.00
TOTAL FILING FEE ENCLOSED	**$ 00.00**

The filing fee for this application will be paid when the missing parts (e.g., declaration and assignment) are filed.

Also enclosed herewith for filing in connection with the enclosed application are:

____ Oath;
____ A copy of the executed Declaration;
XX Disclosure Statement;
____ Letter referencing previously filed disclosure document; number _____ filed _____;
XX Verified Statement claiming small entity status as filed in parent application serial no. 09/201,528;
____ An assignment of the application to:_____

XX Claim(s) to priority:

Serial Number	Filing date
09/293,526	4/15/99
09/201,528	11/30/98
60/093,891	7/23/98 - U.S. Provisional

NO PAYMENT OF THE ISSUE FEE, ABANDONMENT OF, OR TERMINATION OF PROCEEDINGS HAS OCCURRED IN THE ABOVE-IDENTIFIED APPLICATION 09/293,526 OR 09/201,528.

____ A certified copy of a _____ patent application or inventor's certificate, filed _____ and serial no. _____, upon which a claim to priority is made;
____ Other: _____

Respectfully submitted,

7-22-99

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*****EXPRESS MAIL CERTIFICATION*****

"Express Mail" mailing label number: **EL373124724US**
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I hereby certify that this patent application and related papers is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Box Patent Application, Washington, C. 20231.

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Robert Brush
Name of person mailing paper or fee

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN	Docket No. 533/168

Serial No.	Filing Date	Patent No.	Issue Date

Applicant/ Patentee: EDWARD A. Ted Ludvig, Nathan Osborn, Donald F. Gordon

Invention: **METHOD AND APPARATUS FOR COMBINING VIDEO SEQUENCES WITH AN INTERACTIVE PROGRAM GUIDE**

I hereby declare that I am:

- ☐ the owner of the small business concern identified below:
- ☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **DIVA Systems Corporation**

ADDRESS OF CONCERN: **333 Ravenswood Avenue, Menlo Park, CA 94025**

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in:

- ☒ the specification filed herewith with title as listed above.
- ☐ the application identified above.
- ☐ the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ no such person, concern or organization exists.
- ☐ each such person, concern or organization is listed below.

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME _____
ADDRESS _____

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: **Stephanie Storms**

TITLE OF PERSON SIGNING OTHER THAN OWNER: **Vice President**

ADDRESS OF PERSON SIGNING: **DIVA Systems Corporation**
333 Ravenswood Avenue
Menlo Park, California 94025

SIGNATURE: Stephanie A. Storms DATE: 11/24/98

METHOD AND APPARATUS FOR ENCODING A USER INTERFACE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims benefit of U.S. provisional patent application serial number 60/093,891 filed July 23, 1998 which is hereby incorporated herein by reference. This application is also a continuation-in-part of commonly assigned U.S. Patent Application serial number 09/293,526 filed April 15, 1999 and commonly assigned U.S. Patent Application serial number 09/201,528 filed November 30, 1998, both of which are hereby incorporated herein by reference.

BACKGROUND OF THE DISCLOSURE

1. Field of the Invention

The invention relates to electronic program guides and, more particularly, the invention relates to a technique for encoding a user interface of an information distribution system.

2. Description of the Background Art

In several communications systems, the data to be transmitted is compressed so that the available transmission bandwidth is used more efficiently. For example, the Moving Pictures Experts Group (MPEG) has promulgated several standards relating to digital data delivery systems. The first, known as MPEG-1 refers to ISO/IEC standards 11172 and is incorporated herein by reference. The second, known as MPEG-2, refers to ISO/IEC standards 13818 and is also incorporated herein by reference. A compressed digital video system is described in the Advanced Television Systems Committee (ATSC) digital television standard document A/53, and is incorporated herein by reference.

The above-referenced standards describe data processing and manipulation techniques that are well suited

to the compression and delivery of video, audio and other information using fixed or variable rate digital communications systems. In particular, the above-referenced standards, and other "MPEG-like" standards and techniques, compress, illustratively, video information using intra-frame coding techniques (such as run-length coding, Huffman coding and the like) and inter-frame coding techniques (such as forward and backward predictive coding, motion compensation and the like). Specifically, in the case of video processing systems, MPEG and MPEG-like video processing systems are characterized by prediction-based compression encoding of video frames with or without intra- and/or inter-frame motion compensation encoding.

Over the past few years, television has seen a transformation in a variety of means by which its programming is distributed to consumers. Cable television systems are doubling or even tripling system bandwidth with the migration to hybrid fiber coax (HFC) cable plant thereby offering a larger number of channels to the viewer. Customers unsatisfied with their local cable systems have switched in high numbers to direct broadcast satellite (DBS) systems. And, a variety of other approaches have been attempted focusing primarily on high bandwidth digital technologies, intelligent two way set top boxes, or other methods of trying to offer service differentiated from standard cable and over the air broadcast systems.

With this increase in bandwidth, the number of programming choices has also increased. Leveraging off the availability of more intelligent set top boxes, several companies such as Starsight and Prevue Guide have developed elaborate systems for providing an interactive listing of a vast array of channel offerings, expanded textual information about individual programs, the ability to look forward to plan television viewing as much as several weeks in advance, and the option of automatically programming a VCR to record a future broadcast of a television program.

Unfortunately, the existing program guides have several drawbacks. They tend to require a lot of memory, some of

them needing upwards of one megabyte of set top terminal (STT) memory. They are very slow to acquire their current database when they are activated for the first time or are subsequently restarted (e.g., a large database may be downloaded to a STT using only a vertical blanking interval (VBI) data insertion technique). Disadvantageously, such slow database acquisition may result in out of date database information or, in the case of a pay per view (PPV) or video-on-demand (VOD) system, limited scheduling flexibility for the information provider. The user interface to existing program guides does not usually look like a typical television control interface; rather looks like a 1980's style computer display (i.e., blocky, ill-formed text and/or graphics).

Additionally, the present program guides may provide an advertising or preview region along with the program guide graphics. However, the insertion of these additional video signals is performed using an analog compositor that merely inserts (overlays) the additional imagery into the broadcast stream. The analog compositing process is accomplished and then the new analog video containing an advertisement or preview and the program guide are recorded on tape for subsequent broadcast. This compositing process is not accomplished in real time at the head end of the cable system and, consequently, the program guide can not contain targeted advertising for a particular household or a particular neighborhood or region. The program guide with its associated preview or advertising is broadcast to all subscribers connected to the head end of the cable system. Additionally, these program guides are generally passive, in that, the viewer sees the program guide information change on the screen to indicate different programs and their associated channels. However, there is no provision enabling a viewer to interact with the program guide display to scroll through the channel or channels that are available. Because such scrolling in an analog system requires a splice to a new program guide video sequence, the program guides that are interactive do not include

advertising video or other video information with the program guide.

Therefore, it is desirable to provide a method and apparatus for encoding an interactive program guide.

SUMMARY OF THE INVENTION

The disadvantages associated with the prior art are overcome by the present invention of a method and apparatus for encoding user interface of an information distribution system. One embodiment of such user interface is an interactive program guide (IPG) that forms an IPG screen or page containing a graphical guide region and a video region playing at least one video sequence. The invention is a method and apparatus for performing ensemble encoding of one or more IPG pages. The invention comprises a plurality of compositors that combine background information, informational video and program guide graphics into a single sequence of video frames. The sequence is then digitally encoded to form an MPEG-like bitstream. The same background information and informational video is composited with a different program guide graphic to form another video sequence that is also encoded. A plurality of such bitstreams are produced with each sequence containing a different program guide graphic. The encoding is performed using a common coding profile and a common clock for each of the encoders. The encoded sequences are then multiplexed into at least one transport stream such that all the encoded sequences are transmitted to subscriber equipment using one or more transport streams. As such, the subscriber can transition from one program guide page to the next without interruption of the background or informational video as the program guide page graphic is changed.

The informational video may appear in multiple locations upon the IPG screen. Promotional or advertising video may appear in one portion while an animated graphic appears in another location. Each of the informational video streams may have a different rate of display. The

encoders handle different video rates by using slice based encoding of the composite image sequence.

One example of a program guide that is encoded in accordance with the invention has each graphic containing a set of programs (e.g., channels) listed along a left, vertical axis and each program associated with the channel is identified in a rectangular cell that extends toward the right. The horizontal axis represents time and about 1.5 hour of programming for ten channels is shown in each program guide graphic page. The informational video is generally contained in one or more regions above the program graphic.

In another example of a program guide that is encoded in accordance with the invention has each graphic containing a set of programs (e.g., channels) listed along a left, vertical axis and each program associated with the channel is identified in a cell that is listed beneath a time axis. The horizontal axis represents time and about 1.5 hours of programming for eight channels is shown in each program guide graphic page. Each channel is associated with text that represents three programming slots, one for each half hour in the time axis. The informational video is generally contained in one or more regions next to the program graphic, i.e., a guide region is on the left half of the screen and the video region is on the right half of the screen or vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a high-level block diagram of an information distribution system that uses the interactive program guide of the present invention;

FIG. 2 depicts a block diagram of an IPG generator of the present invention;

FIG. 3 depicts a block diagram of a compositor unit that produces background/informational frame sequence in accordance with the present invention;

FIG. 4 depicts a block diagram of an IPG compositor that inserts an IPG graphic into the background/informational frame sequence;

FIG. 5A-5C depicts a series of illustrative IPG pages;

FIG. 6 depicts another example of an IPG page that can be produced by the invention; and

FIG. 7 depicts a PID map for a set of IPG pages encoded by the invention.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

DETAILED DESCRIPTION

FIG. 1 depicts a high-level block diagram of an information distribution system 100, e.g., a video-on-demand system or digital cable system, that incorporates the present invention. The system 100 contains service provider equipment (SPE) 102 (e.g., a head end), a distribution network 104 (e.g., hybrid fiber-coax network) and subscriber equipment (SE) 106. This form of information distribution system is disclosed in commonly assigned U.S. patent application serial number 08/984,710 filed December 3, 1997. The system is known as the OnSet™ system provided by DIVA Systems Corporation of Menlo Park, California.

In general, the SPE 102 produces a plurality of digital bitstreams that contain encoded information (e.g., television programming in an MPEG-like compressed form). These bitstreams are modulated using a modulation format that is compatible with the distribution network 104. The subscriber equipment 106, at each subscriber location 106_1, 106_2, ..., 106_n, comprises a demodulator/decoder 124 and a display 126. Upon receiving a bitstream, the subscriber equipment decoder 124 extracts the information from the

received signal and decodes the stream to produce the information on the display, i.e., produce a television program or program guide page.

In an interactive information distribution system such as the one described in commonly assigned U.S. patent application 08/984,710, filed December 3, 1997, the program bitstreams are addressed to particular subscriber equipment locations that requested the information through an interactive menu. An appropriate interactive menu structure for requesting video on demand is disclosed in commonly assigned U.S. patent application serial number 08/984,427, filed December 3, 1997.

To assist a subscriber (or other viewer) in selecting programming, the SPE 102 produces a interactive program guide (IPG) in accordance with the present invention. The IPG of the present invention contains program information, e.g., title, time, channel, program duration and the like, as well at least one region displaying full motion video, i.e., a television advertisement or promotion. Such informational video is provided in various locations within the program guide screen.

FIG. 5A illustrates a first example of an IPG 500 that is produced in accordance with the present invention. The IPG 500 contains a background 502, a plurality of video display regions 504, 506, and 508, and a program guide graphic 510. The program guide graphic 510 contains a left (or right), vertical axis 512 representing the available channels and a bottom (or top), horizontal axis 514 represents time. Generally, about 1.5 to 2 hours of programming are displayed in the guide graphic 510. Each program (e.g., P1, P2, P3, and so on) is identified by a program title within a rectangular cell. The extent of the cell (its length) indicates the duration of the program and the starting location of the left edge of the cell indicates the starting time of the program. The arrangement of the program identification cells in this manner is a conventional arrangement in which programming guides have been organized in print for years.

Returning to FIG. 1, the invention produces the IPG (500 of FIG. 5A) using a novel compositing technique that enables full motion video to be positioned within an IPG and have the video seamlessly transition from one IPG page to another. FIG. 1 depicts the components that are necessary to produce an IPG page that contains at least one video region. The embodiment of the invention is described as having advertising displayed in the video region or regions. However, advertising is merely illustrative of a type of informational video and any sequence of video or graphic information can be displayed in these regions. To this end, the SPE 102 contains a video storage device 108, an informational video selection and monitoring system 110, an IPG generator 116 (an ensemble encoder), a background storage device 118, a controller 114, an IPG grid generator 120, and a digital video modulator 122. The video selection and monitoring system 110 controls timing of the informational video display and, if the video is an advertisement, tracks video utilization to facilitate billing to an advertiser whenever a particular advertisement is transmitted. Thus, the video selection and monitoring system 110 requests that the storage device 108 (e.g., a disk drive or magneto-optical drive) recall and send to the IPG generator 116 a particular video sequence. The video is stored in the storage device 108 as frame-based digital video (i.e., 601 format video) and associated audio. Alternatively, compressed or uncompressed analog video as well as other formats of video information may be stored in the storage device 108. These formats are converted to 601 format prior to sending the video to the IPG generator 116.

As the video is recalled from device 108, each video sequence is coupled to the IPG generator 116. As such, three video streams and one audio stream (e.g., an audio stream associated with one of the advertisements) are provided to the IPG generator 116. Additionally, a background image is recalled from the storage device 118 under instructions from the controller 114. The background image is generally a static graphic, but it may be a video

frame sequence containing moving imagery. Lastly, the IPG grid generator 120 provides a program guide graphic to the IPG generator 116. The IPG data for the graphic can be provided from any one of a number of sources such as a network cable feed, an internet site, a satellite feed, and the like. The guide program data is formatted, for example, into the rectangular grid graphic of program cells (screen 500 of FIG. 5A) by the IPG grid generator 120. As shall be discussed below with respect to FIG. 6, other IPG page layouts may be used and are considered to be within the scope of this invention.

The IPG generator 116 performs ensemble encoding by combining the three video sequences, the background and the guide graphics into a comprehensive IPG display such as the one depicted as IPG page 500 in FIG. 5A or IPG page 600 in FIG. 6. As shall be described in detail below, the informational video is overlaid onto the background to form a background/video composite and then various IPG grids are overlaid upon the background/video composite. In this manner, a number of IPG "pages", for example, fifteen of them, are produced, where each page depicts ten channels of programming information. Each of these IPG pages is encoded within the IPG generator 116 into a compressed digital bitstream, e.g., an MPEG compliant bitstream. The bitstream is then modulated by the digital video modulator 122 using a modulation format that is compatible with the distribution network 104. For example, in the OnSet™ system the modulation is quadrature amplitude modulation (QAM); however, other modulation formats could be used.

The subscriber equipment 106 contains a demodulator/decoder 124 and a display 126 (e.g., a television). The demodulator/decoder 124 demodulates the signals carried by the distribution network 104 and decodes the demodulated signals to extract the IPG pages from the bitstream. As shall be described below, each of the IPG pages is identified with a unique program identification code (known as a PID) that is used by the demodulator/decoder 124 to select a bitstream for decoding.

The decoded IPG page is displayed, as shown in FIG. 5A, to the subscriber or viewer. As the viewer selects another IPG page containing other program information, generally by scrolling to the bottom of the IPG graphic 510 using a remote control interface 128 or some other input device, the IPG page stream associated with the next PID is decoded. The only change the viewer sees is the IPG graphic changes (from, for example, graphic 510_1 to 510_2), the informational video and its associated audio seamlessly continues playing. This seamless play occurs because each of the IPG pages contains the same, frame synchronized background and informational video and only the IPG graphic changes from page to page. As such, the decoder seamlessly transitions from one IPG page to another.

FIG. 2 depicts a block diagram of the IPG generator 116. The IPG generator 116 contains a compositor unit 200, a plurality of IPG grid compositors 202, a plurality of video encoders 204 (e.g., MPEG-2 compliant encoders), a common profile and clock generator 250, a transport stream multiplexer 206, an audio delay 208, an audio encoder 210 (e.g., an Dolby AC-3 audio encoder) and the IPG grid generator 120. The compositor unit 200 positions the informational video sequences (vs2, vs3, vs4) upon the background video imagery (vs1). To facilitate positioning, the controller (114 in FIG. 1) provides the compositor unit 200 with the coordinates of one corner of each informational video and provides a size indicator for each rectangular region in which the video will be displayed relative to the background. The compositor unit 200 performs the placement and fusing of the imagery to form background/information video frame sequence. Further detail of this compositing process is provided below with respect to FIG. 3.

The composite image (e.g., three, full motion video frame sequences positioned upon a background image, the background/informational video) is coupled to a plurality of IPG grid compositors 202_1, 202_2, 202_3, ..., 202_{15} (collectively referred to as compositors 202). The compositors 202 combine the respective IPG graphics with the

background/informational video combination to produce a plurality of video frame sequences containing a composite of the background, the informational video, and the IPG graphics. There is one frame sequence for each IPG graphic, e.g., fifteen sequences in all. As discussed previously, the IPG graphic is produced by the IPG grid generator 120. The IPG grid generator 120 actually produces two items, one is the IPG grid background image (the IPG grid graphic discussed above and shown as graphic 510 in FIG. 5A), and IPG grid foreground overlay graphic data that is used to generate highlighting and other special effects in the displayed IPG screen. Additionally, this data attributes functionality to the highlighted elements such as selecting another IPG page, selecting a program to view, exiting the system, and the like. These special effects and functionality are discussed below with respect to FIGS. 5A, 5B and 5C.

Each of the frame sequences (IPG screen sequences V1, V2, V3, ..., V15) are coupled from the compositors 202 to the plurality of video encoders, e.g., real time MPEG-2 encoders 204_1, 204_2, 204_3, ... 204_n (collectively encoders 204). Each encoder 204 encodes an IPG screen sequence to form a compressed video bitstream, e.g., an MPEG-2 compliant bitstream. The encoders use a common encoding profile and common clock supplied by the encoding profile and clock generator 250. As such, each sequence of IPG frames are synchronously encoded in the same manner.

The IPG grid foreground overlay graphics data is also coupled to the multiplexer 206 from the IPG grid generator 120. This graphics data is generally sent as "user data" or "private data" within the transport stream. Further discussion of the graphics data is provided below.

If the informational video in each IPG page have differing amounts of motion, the encoders can encode the video in a slice-based manner. As such, each frame is divided into a plurality of horizontal stripes of macroblocks. Each frame contains stripe start and stop

identifiers. The information (pixels and/or macroblocks) between the start and stop indentifiers can be encoded in a different manner than other portions of a given stripe. Consequently, a two dimensional region comprising portions of adjacent stripes can be encoded differently from other portions of the frame. The encoded information from the two dimensional region forms a bitstream that is identified by its own program identifier. At the subscriber equipment, the demodulator/decoder decodes the information in each slice, then reassembles the frame by placing the decoded slices into appropriate locations as identified by the slice start/stop identifiers. The two dimensional regions can be specified to align with the informational video such that the regions can contain video having different motion, i.e., fast versus slow motion. Consequently, one region could contain a slow moving animated character while another region could contain a fast moving sporting event promotion and both regions would be coded and decoded accurately.

All the compressed video streams (E1, E2, E3, ..., E15) containing program guide information are multiplexed into a transport stream using multiplexer 206. These compressed video streams may contain the stripe-based encoded streams as well. In addition to the video information, audio information associated with one of the informational videos is also encoded and supplied to the multiplexer 206. The audio signal is delayed in audio delay 208, then encoded in the audio encoder 210. The delay compensates for the time required to perform video encoding of the associated video vis-a-vis the audio encoding. The compressed audio data is coupled to the multiplexer 206 for incorporation into the transport stream.

A transport stream, as defined in ISO standard 13818-1 (commonly known as the MPEG-2 Systems specification), is a sequence of equal sized packets, each 188 bytes in length. Each packet has a 4-byte header and 184 bytes of data. The header contains a number of fields, including packet identification number (PID). The PID field contains 13 bits and uniquely identifies each packet that contains a portion

of a "stream" of video information as well as audio information and data. As such, to decode a particular video bitstream (or audio bitstream or data) for viewing, the decoder in the subscriber equipment extracts packets containing a particular PID and decodes those packets to create the video (and audio) for viewing.

Each of the fifteen bitstreams representing the IPG page sequences within a particular transport stream are uniquely identified by a PID. In the preferred embodiment, fifteen PID's are multiplexed into a single transport stream. Certainly, less of more IPG bitstreams can be included in a transport stream as bandwidth permits. Additionally, more than one transport stream can be used to transmit the IPG bitstreams. For example, additional IPG pages may be encoded that represent additional time within a day or additional channels. The bitstreams representing the additional IPG pages are transmitted in additional transport streams. As such, many IPG pages representing 24 hours of programming on hundreds of channels can be broadcast to the subscriber equipment for selective display to a viewer.

FIG. 7 depicts a graphical representation of PID assignment to each IPG page. The graph 700 contains a PID axis 702 and a time axis 704. At time 1 (t1) and, more than likely, within a single transport stream, the graphics 706 for a first IPG page and the video 708 for a first IPG page are sent in PID1. Then, in PID2, the graphics 710 for a second IPG page and the video 708 for the second IPG page are sent. Note that the video is the same in each IPG page that is sent at time 1 and only the graphics (g_1, $g_2 \ldots g_{15}$) change from IPG page to IPG page. The change in graphics may represent either different time intervals or different channel groupings shown in the IPG pages. In time 2, the grouping and encoding is repeated using different video. The process is repeated until all the IPG pages are generated to cover all available channels over a 24 hour period. The transport streams carrying the encoded IPG pages are then broadcast to all viewers.

An exemplary transport stream consists of N programs multiplexed together into one transport stream. Each program has it's own video PID, which contains all the MPEG bits for a single guide page. All the programs share the same audio and PCR.

To change pages in the guide, it is required to switch between programs (video PIDs) in a seamless manner. This cannot be done cleanly using a standard channel change by the STT switching from PID to PID directly, because such an operation flushes the video and audio buffers and typically gives half a second blank screen.

To have seamless decoder switching, a splice countdown (or random access indicator) method is employed at the end of each video sequence to indicate the point at which the video should be switched from one PID to another.

Using the same profile and constant bit rate coding for each encoding unit, the generated streams for different IPG pages are formed in a similar length compared to each other. This is due to the fact that the source material is almost identical differing only in the characters in the guide from one page to another. In this way, while streams are generated in close lengths, they are not exactly the same lengths. For example, for any give sequence of 15 video frames, the number of transport packets in the sequence varies from one guide page to another. Thus a finer adjustment is required to synchronize the beginnings and ends of each sequence across all guide pages in order for the countdown switching to work.

The invention provides the act of synchronization of a plurality of streams that provides seamless switching at the STT.

Three methods are provided for that purpose:

First, for each sequence you can count the longest guide page for that particular sequence, and then add sufficient null packets to the end of each other guide page so that all the guide pages become the same lengths. Then add the switching packets at the end of the sequence, after all the null packets.

The second method requires buffering of all the packets for all guide pages for each sequence. If this is allowed in the considered system, then the packets can be ordered in the transport stream such that the packets for each guide page appear at slightly higher or lower frequencies, so that they all finish at the same point. Then the switching packets are added at the end of each stream without the null padding.

A third method is to start each sequence together, and then wait until all the packets for all the guide pages have been generated. Once the generation of all packets is completed, switching packets are placed in the streams at the same time and point in each stream.

Depending on the implementation of STT decoder units and requirements of the considered application, each one of the methods can be applied with advantages. For example, the first method, which is null-padding, can be applied to avoid bursts of N packets of the same PID into a decoder's video buffer faster than the MPEG specified rate (e.g., 1.5 Mbit).

The same principles of splicing and synchronization techniques are applicable to a plurality of different transport stream forms, including recombinant stream.

The teachings of the above three methods can be extended apply to similar synchronization problems and to derive similar methods.

Returning to FIG. 1, the transport stream is coupled to a digital video modulator 126 where it is modulated onto a carrier that is appropriate for transmission through the distribution network 104. For a hybrid fiber coax based distribution network 104, the modulation is quadrature amplitude modulation (QAM).

The subscriber equipment 106 is connected to the network 104 and receives the transport stream from the network 104. A demodulator/decoder 124 in each of the terminals extracts the transport stream from the modulation, demultiplexes the bitstreams within the transport stream, and decodes a selected program guide video sequence. Since

the program guide bitstreams are contained in the transport stream, the terminal selects a particular program guide using its unique packet identifier (PID) that causes a video demodulator/decoder 124 to decode the program guide bitstream identified by that PID (or PIDs in the case of slice based encoding). When the user selects another program guide, another stream is decoded based upon the newly selected PID or PIDs. By transmitting many program guide streams in a common transport stream and by frame locking the program guide source, encoding and decoding processes, the latency experienced as a subscriber selects one guide page after another is undetectable. Also, because the informational video is the same and frame synchronized in each program guide bitstream with the only difference being a different guide graphic, the subscriber sees a transition in the guide graphic, but the informational audio and video is seamlessly presented to the viewer.

FIG. 3 depicts a detailed block diagram of the compositor unit 200. The compositor unit 200 contains a plurality of serial-to-parallel converter modules 300 and 304, a plurality of image compositors 302, 306, and 308, an optional parallel-to-serial converter module 310 and a PCI bus 312. The informational video signals vs2, vs3, vs4 are assumed to be supplied as a conventional pixilated video signal in a 601 format (digital video) having each frame of 601 video synchronized with the frames of the other advertisement video signals. Generally, 601 video is supplied as a serial bitstream that is converted into parallel stream, i.e., one complete video frame is coupled to the compositor at a time.

More specifically, the background imagery vs1 and the first informational video vs2 are coupled to the serial-to-parallel converter module 300. The frames of each of these video signals are then coupled to the compositor 302. In operation, the compositor 302 synchronizes the frames, resizes the informational video to fit into a predefined rectangular region, positions the rectangular region on the background and merges the two video frame sequences. The

controller 114 of FIG. 1 uses the PCI bus 312 to instruct the compositor as to the size of the informational video region and its position on the background. A commercially available compositor is used to perform the foregoing operations using 601 video signals.

The composited video sequence containing the background and first informational video is then coupled to the second compositor 306 such that the second informational video is composited onto the background and first video. The third compositor 308 performs a similar function to produce a frame sequence having the background and three informational video sequences composited into a single sequence. The size and position of the informational video display regions is controlled by signals from the controller via the PCI bus 312. The output sequence from the third compositor 308 is optionally coupled to the parallel-to-serial converter module 310 to produce a serial bitstream. Generally, the parallel data is coupled directly to the IPG grid compositors (202 in FIG. 2); however, if the compositor unit 200 is not physically near the compositors 202, then the parallel-to-serial converter 310 may be used to improve the integrity of the data as it is communicated over a distance. Although only three informational videos were added to the background using three compositors, clearly more compositors can be used if additional informational video sequences are desired.

FIG. 4 depicts a block diagram of one of the IPG grid compositors 202, e.g., compositor 202_1. The compositor 202_1 contains an alpha framestore 400, a video framestore 402 and a compositor 406. The alpha framestore 402 stores a bitmap array of weighting functions that control the degree of transparency that the IPG grid will have with respect to the background/informational frame sequence, i.e., the bitmap contains a value of transparency for each and every pixel in the IPG graphic. As such, the alpha framestore information controls the amount of background/advertising video scene that can be viewed "through" the IPG graphic. The video frame store 402 buffers the IPG graphic on a frame-by-frame

basis to ensure alignment with the background/informational video frames. The compositor 406 combines the IPG graphic with the background/informational frames produced by the compositor unit 200 in FIG. 2. The position and size of the IPG graphic with respect to the background is controlled, via the control signal coupled to the compositor 406, by the controller 114 of FIG. 1.

Each of the IPG graphics, e.g., fifteen, are separately composited in this manner with the background and the advertising. As such, fifteen separate bitstreams, one contains each IPG graphic, are encoded and arranged in the transport stream.

FIG. 5A depicts a first illustrative IPG page layout 500_1 as decoded by the decoder of the subscriber equipment. The page 500_1 is one of the fifteen available screens (collectively referred to as IPG pages 500) that can be decoded by appropriate selection of a screen PID within a transport stream. Similar IPG screens can be also decoded from other transport streams that are broadcast to the subscriber equipment from the head end equipment. As decoded, the informational video in regions 504, 506 and 508 plays as any decoded video streams. The audio signal associated with one of the informational video sequences also is decoded and plays in conjunction with the video (i.e., audio follows video). The first IPG graphic 510 contains, for example, program information concerning channels 1 through 10. The subscriber, by manipulating an input device, can scroll through the program selections. As the scrolling function transitions from one cell to another, the cell is highlighted by a change in the on-screen display graphics. These graphics are sent to the subscriber equipment as "user data" and/or "private data" within the transport stream. A detailed description of the operation of the IPG 500 is presented in commonly assigned US patent application _____, filed simultaneously herewith (Attorney docket number 070 CIP2) and herein incorporated by reference.

When the subscriber reaches the bottom of the IPG graphic, i.e., the last cell or a special icon (arrow), a different PID is selected for decoding, i.e., the PID for the next IPG page containing channels 11 through 20. The decoder begins decoding the next stream as soon as it is selected. The connection between IPG pages is a functional attribute that is generally transmitted to the subscriber equipment as user data within the transport stream. Since the background and the informational video were synchronously added to the video sequence that become the IPG pages, the informational video seamlessly transitions from one screen to another without any visible anomalies. The IPG graphic is the only portion that changes from 510_1 to 510_2. The process of transitioning from one IPG page to another can be accomplished by incrementing or decrementing through the IPG pages. Additionally, parallel pages may be available to display additional time slots. As such, IPG pages representing programming in other time periods could be accessed by, for example, left and right arrows. These parallel pages may be carried in additional transport streams or in the same transport stream.

A second illustrative IPG page layout 600 is shown in FIG. 6. This IPG page layout is encoded in the exact same manner as the layout 500 of FIGS. 5A-5C. The IPG of FIG. 6 operates in a similar manner to that of IPG layout 500. The layout 600 is divided vertically such that the informational video, e.g., a video barker, appears on the right half of the layout and the guide region appears on the left. The guide graphics, graphical icons, background imagery, and informational video are combined and then encoded in the same manner as discussed above. A detailed description of the IPG 600 is presented in commonly assigned US patent application _____, filed simultaneously herewith (Attorney docket number 070 CIP2) and herein incorporated by reference.

Although the foregoing description illustratively disclosed encoding an IPG page, the invention finds use in encoding any form of mixed graphical and video information

screens. For example, the invention can be used to encode a HTML web page in the graphics region and a related television program in the video region. Alternatively, the informational video can be a television program that is displayed within a program guide while a viewer reviews the schedule information. Selecting the video region would enlarge the video to the entire screen, while selecting a program title in the program guide may initiate a preview video to play in second video window. As such, the invention should be interpreted as encompassing any combination of video and graphics that is encoded as a digital bit stream and broadcast from a head end of an information distribution system.

Although various embodiments which incorporate the teachings of the present invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments that still incorporate these teachings.

What is claimed is:

1. A method of producing an encoded user interface comprising:

producing a video frame sequence representing an interactive program guide;

encoding said video frame sequence within a head end of an information distribution system.

2. The method of claim 1 wherein said producing step comprises as step of:

combining, in a frame synchronized manner, background imagery with at least one video sequence and at least one graphic containing program guide information to form said video frame sequence.

3. The method of claim 2 wherein said encoding step further comprises the step of:

encoding the composited frame sequence to compress information therein to form a digital bitstream.

4. The method of claim 2 wherein the combining step further comprises:

compositing, frame-by-frame, at least one video sequence onto said background imagery to form a background sequence; and

compositing a plurality of program guide graphics onto said background sequence, where a different program guide graphic is composited onto said background sequence to form a plurality of program guide frame sequences that represent individual program guide pages.

5. The method of claim 4 wherein said encoding step further comprises:

separately encoding each of said program guide frame sequences to form a digital bitstream for each of the program guide frame sequences.

6. The method of claim 5 further comprising the steps of: multiplexing each of the digital bitstreams into a common transport stream.

7. The method of claim 6 wherein fifteen program guide sequences are formed, encoded, and contained in a common transport stream.

8. The method of claim 5 further comprising:

encoding an audio signal associated with one of the video sequences; and

multiplexing the encoded audio signal into the common transport stream.

9. The method of claim 1 wherein the video frame sequence is a television program.

10. The method of claim 1 wherein the video frame sequence is an advertising program.

11. The method of claim 1 wherein the video frame sequence is encoded using slice based encoding.

12. The method of claim 11 wherein slice based encoding encodes different regions in a different manner than the encoding that is performed upon other portions of the video frame sequence.

13. The method of claim 12 wherein each region is assigned a unique program identifier.

14. The method of claim 8 wherein said multiplexing step further comprises the step of:

multiplexing foreground program guide data into said common transport stream.

15. Apparatus for producing an encoded user interface comprising:

a compositor for producing a frame sequence representing an interactive program guide;

an encoder, coupled to said compositor and located within a head end of an information distribution system, for encoding said frame sequences to form a bitstream.

16. The apparatus of claim 15 wherein said compositor produces a plurality of frame sequences and said encoder comprises a plurality of encoders for encoding each frame sequence in said plurality of frame sequences to form a plurality of bitstreams.

17. The apparatus of claim 16 further comprising

a multiplexer for multiplexing said plurality of bitstreams into a transport stream.

18. The apparatus of claim 17 wherein said multiplexer assigns a different identification code to each said bitstream.

19. The apparatus of claim 17 further comprising a program guide graphics generator for producing said program guide graphics and foreground overlay graphics, where said foreground overlay graphics are included into the transport stream as user data.

20. The apparatus of claim 17 further comprising a program guide graphics generator for producing said program guide graphics and foreground overlay graphics, where said foreground overlay graphics are included into the transport stream as private data.

21. The apparatus of claim 15 wherein said encoder is an MPEG-2 encoder.

22. A bitstream comprising:

a compressed video signal representing one or more program guide pages.

23. The bitstream of claim 22 wherein said compressed video signal is produced using an MPEG encoder.

24. The bitstream of claim 22 wherein said compressed video signal forms a portion of a transport stream.

25. The bitstream of claim 24 wherein said compressed video signal is arranged in packets of data.

26. The bitstream of claim 25 further comprising null packets of data.

27. A method of encoding a plurality of program guide pages comprising the steps of:

encoding each program guide page to form a bitstream representing each program guide page;

determining a longest bitstream;

adding null packets to all bitstreams that are not the longest bitstream until all the bitstreams have the same length; and

adding switching packets to each bitstream.

28. A method of encoding a plurality of program guide pages comprising the steps of:

encoding each program guide page to form a bitstream representing each program guide page;

buffering all the bitstreams for all the guide pages;

retrieving said bitstreams from a buffer;

ordering the bitstreams into a transport stream to equate the length of the transport stream with the length of other transport streams; and

adding switching packets to the transport stream.

29. A method of encoding a plurality of program guide pages comprising the steps of:

encoding each program guide page to form a bitstream representing each program guide page, where said encoding is started at the same time for each program guide page;

assembling a transport stream containing each bitstream in successive order;

adding switching packets into the transport stream after the bitstreams.

Abstract of the Disclosure

A method and apparatus for combining video frame sequences with a video display of an interactive program guide (IPG). The apparatus comprises a plurality of compositors that combine background information, video frame sequences and program guide graphics into a single video frame sequence. The sequence is then digitally encoded to form an MPEG-like bitstream. The same background information and informational video is composited with a different program guide graphic to form another video sequence that is also encoded. A plurality of such sequences are produced with each sequence having a different program guide graphic. Each sequence is encoded and then multiplexed into a transport stream such that all the encoded sequences are transmitted to a subscriber's terminal using a single transport stream. As such, the subscriber can transition from one program guide to the next without interruption of the background or video display as the program guide graphic is changed.

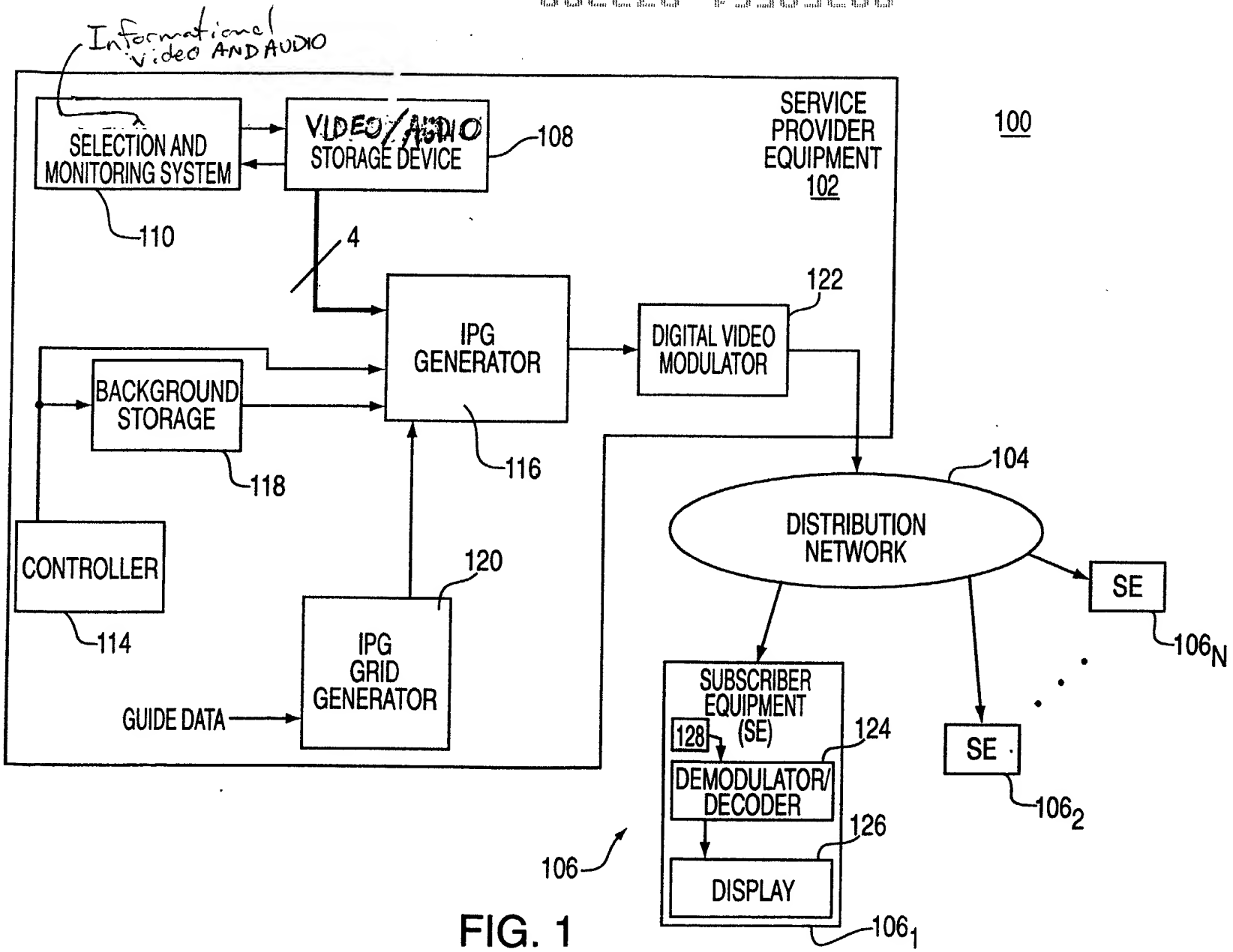


FIG. 1

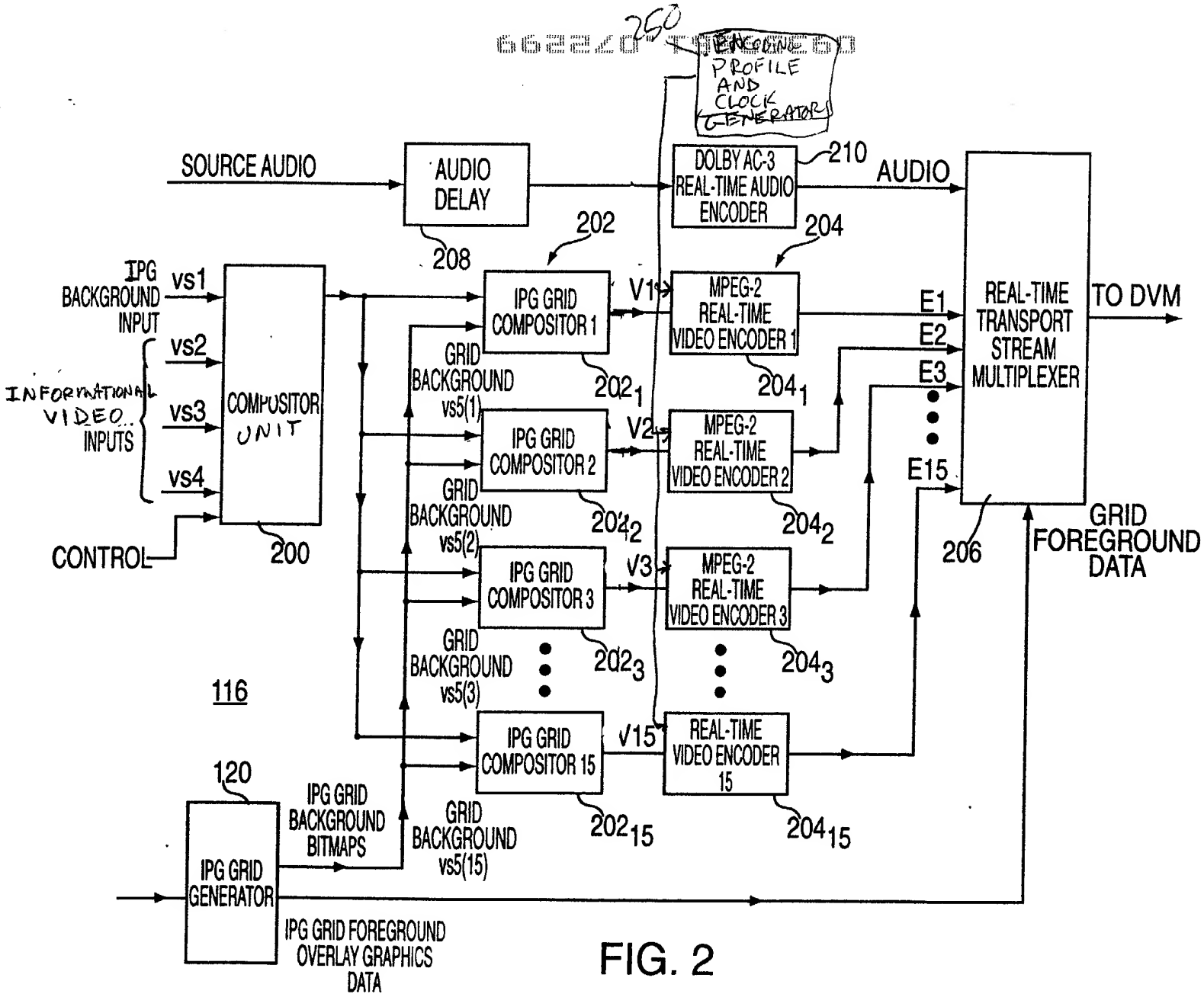

250
PROFILE AND CLOCK GENERATORS
SOURCE AUDIO
AUDIO DELAY
208
DOLBY AC-3 REAL-TIME AUDIO ENCODER
210
AUDIO
202
204
IPG BACKGROUND INPUT
vs1
vs2
vs3
vs4
INFORMATIONAL VIDEO INPUTS
CONTROL
COMPOSITOR UNIT
200
IPG GRID COMPOSITOR 1
V1
MPEG-2 REAL-TIME VIDEO ENCODER 1
E1
E2
E3
E15
REAL-TIME TRANSPORT STREAM MULTIPLEXER
TO DVM
GRID BACKGROUND vs5(1)
202₁
204₁
IPG GRID COMPOSITOR 2
V2
MPEG-2 REAL-TIME VIDEO ENCODER 2
GRID BACKGROUND vs5(2)
202₂
204₂
206
GRID FOREGROUND DATA
IPG GRID COMPOSITOR 3
V3
MPEG-2 REAL-TIME VIDEO ENCODER 3
GRID BACKGROUND vs5(3)
202₃
204₃
116
IPG GRID COMPOSITOR 15
V15
REAL-TIME VIDEO ENCODER 15
120
IPG GRID BACKGROUND BITMAPS
GRID BACKGROUND vs5(15)
202₁₅
204₁₅
IPG GRID GENERATOR
IPG GRID FOREGROUND OVERLAY GRAPHICS DATA

FIG. 2

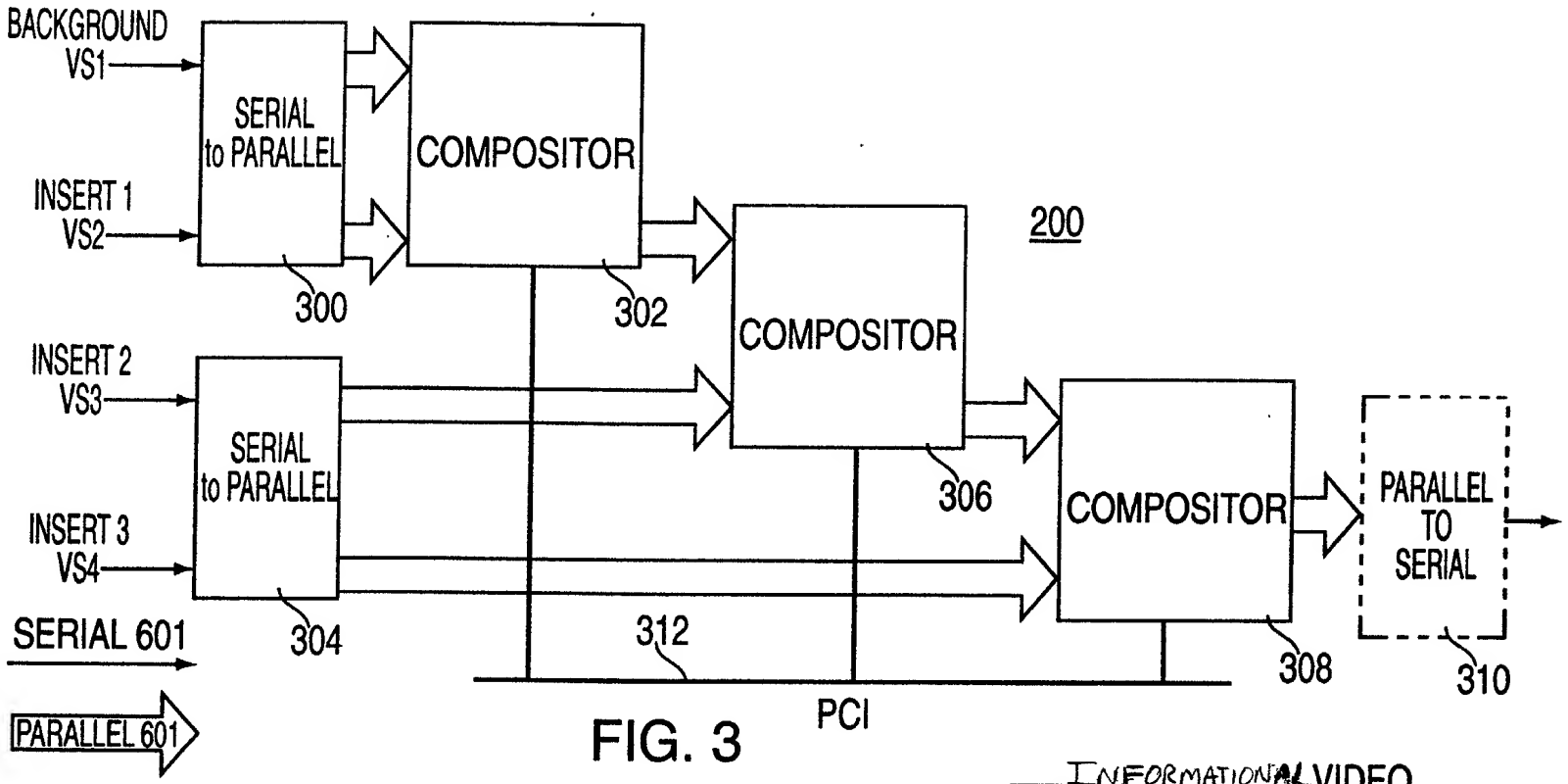


FIG. 3

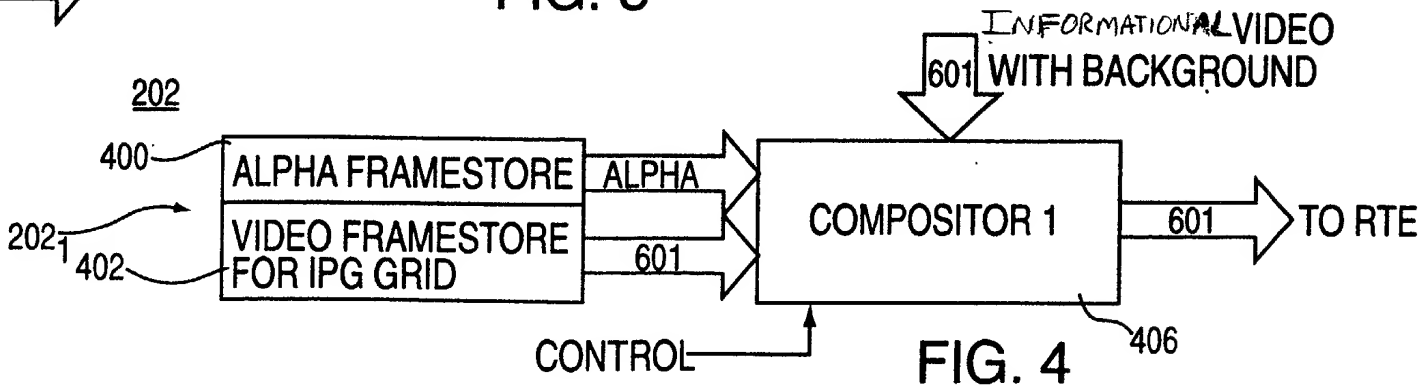


FIG. 4

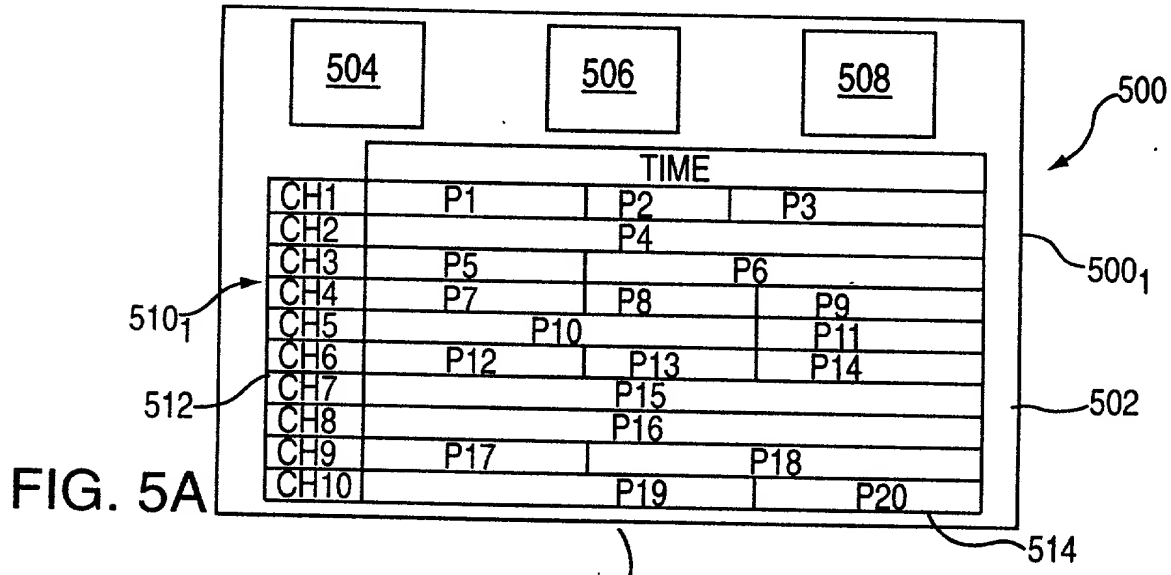


FIG. 5A

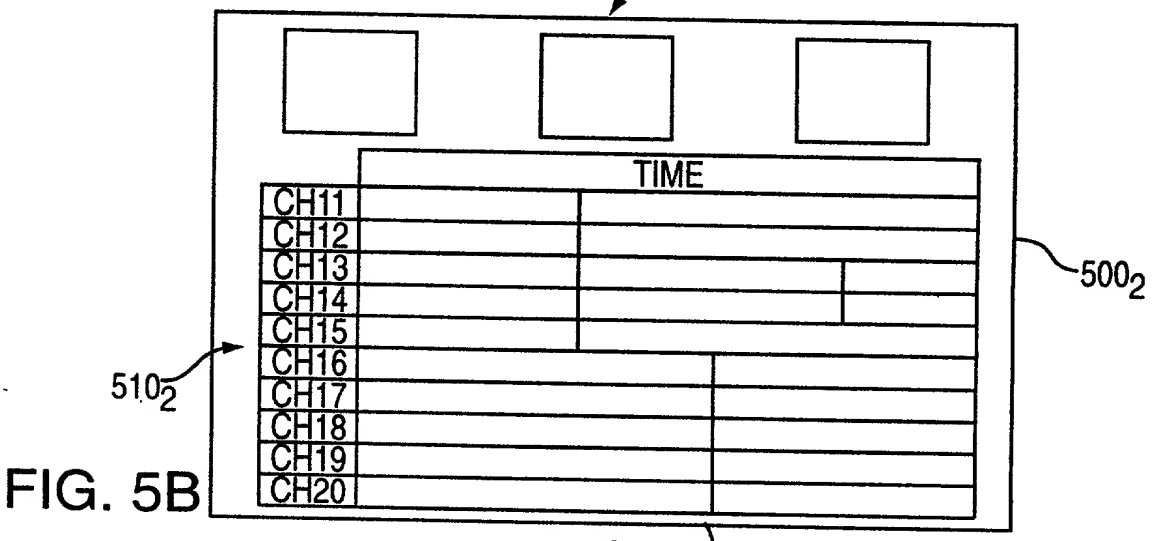


FIG. 5B

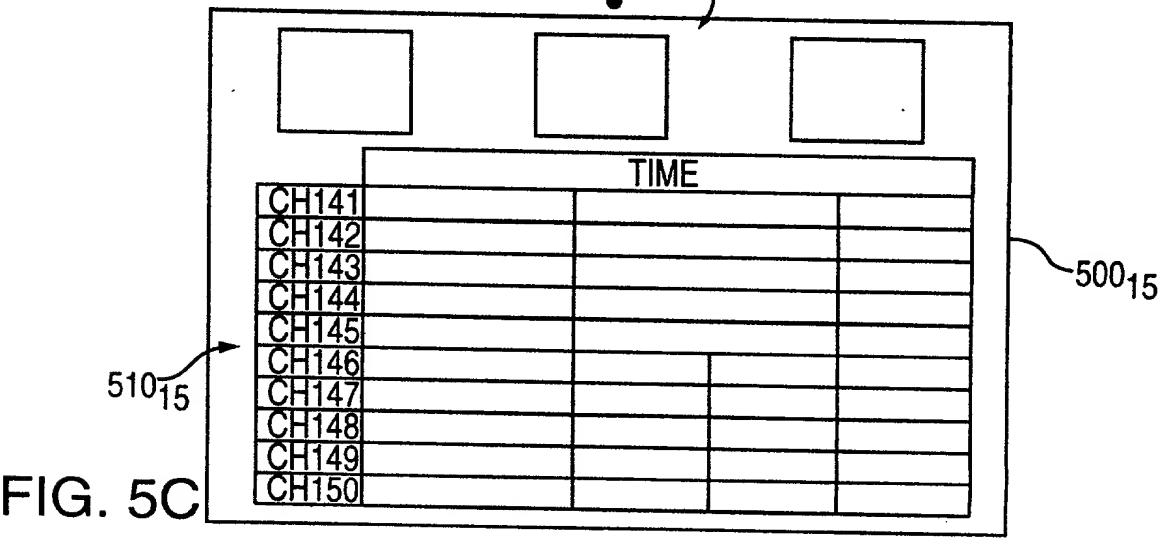
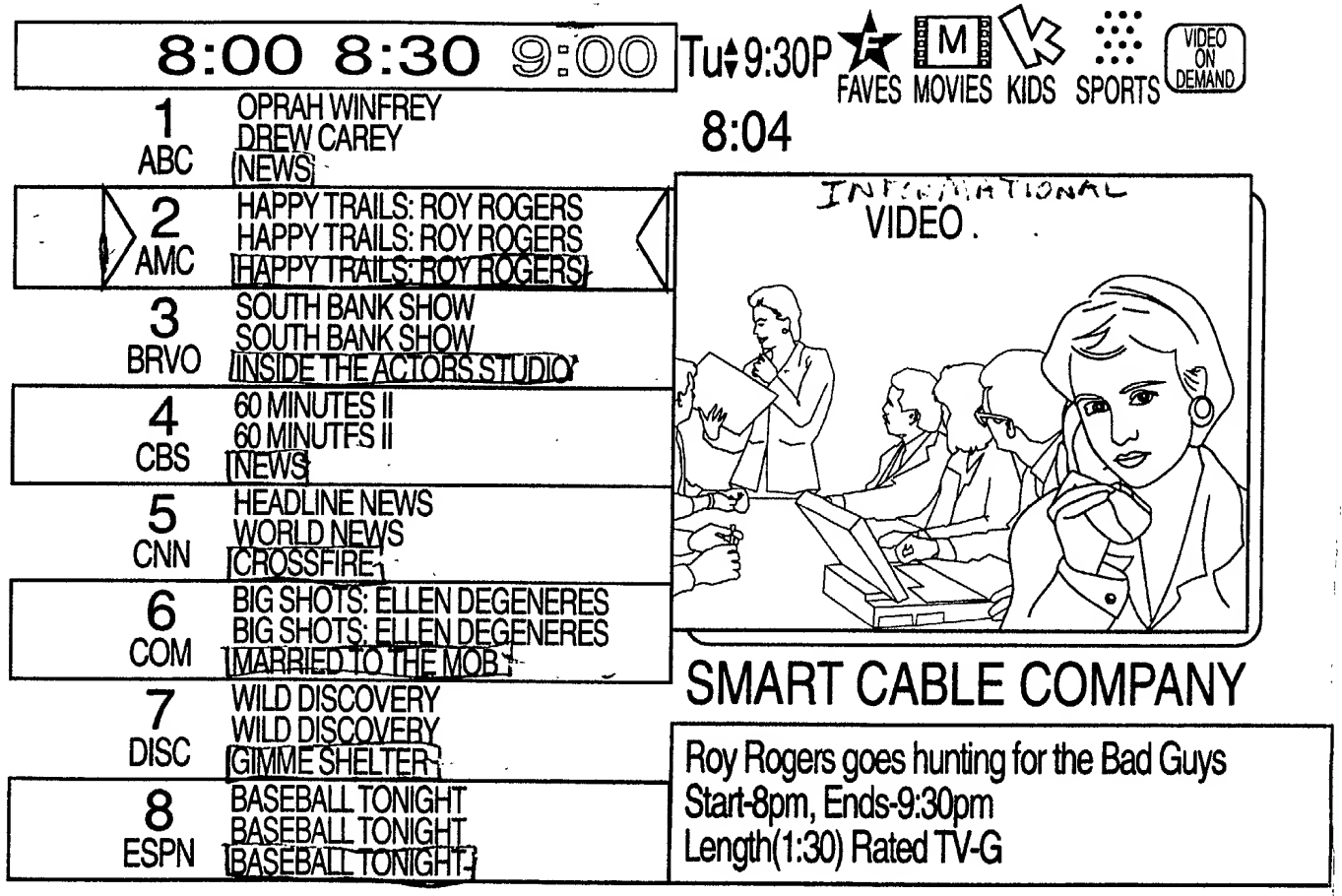


FIG. 5C



600

FIG. 6

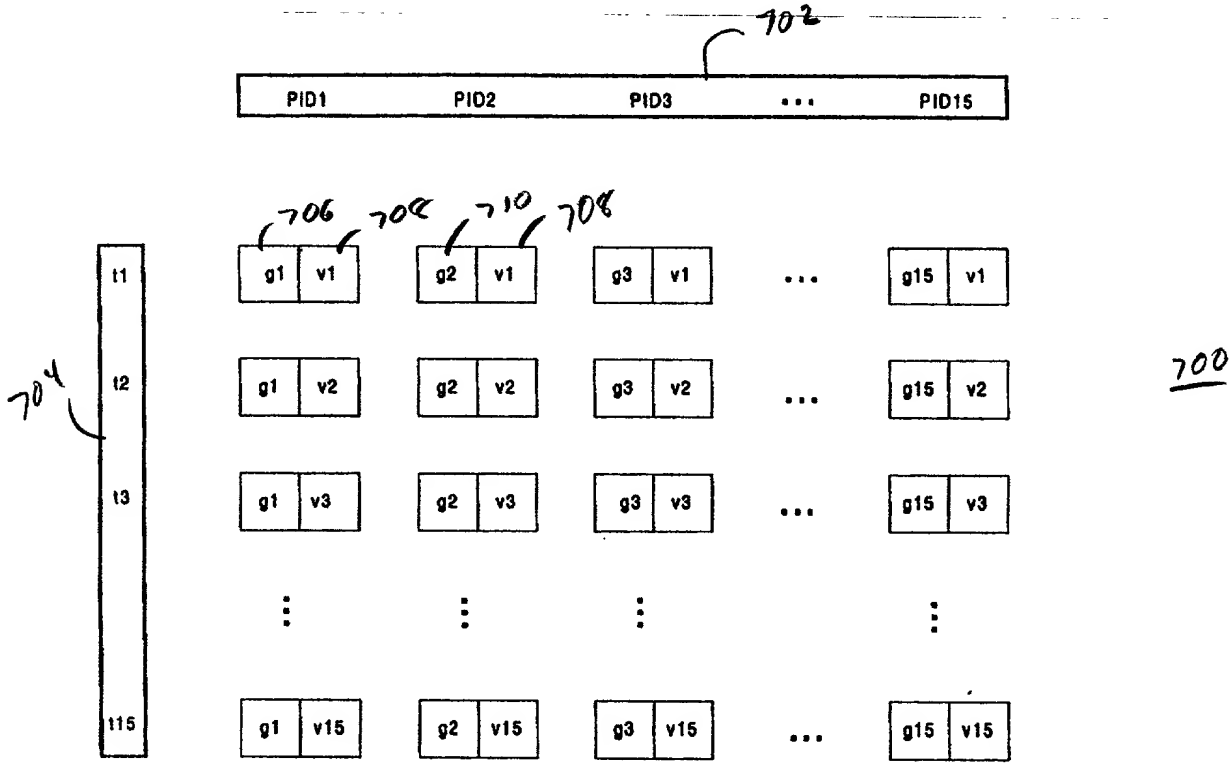

702
PID1
PID2
PID3
...
PID15
706
708
710
708
704
t1
t2
t3
t15
g1 v1
g2 v1
g3 v1
g15 v1
g1 v2
g2 v2
g3 v2
g15 v2
g1 v3
g2 v3
g3 v3
g15 v3
g1 v15
g2 v15
g3 v15
g15 v15
700

FIG. 7